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ABSTRACT

A careful reading of Cronbach and Snow's "Aptitudes and Instructional Methods" reveals that an aptitude-treatment-interaction (ATI) approach is not just a research methodology but is, in fact, a theory oriented philosophy of proposed revision in curriculum and instructional methodology. It is our contention that as a theoretical argument the ATI approach extends current practice in a desirable direction but that this approach, like those it is intended to replace, seriously limits the possibility of optimal adaptation to individual differences. This paper attempts to identify the theoretical premises of the Cronbach/Snow argument and to propose alternatives which are less limiting. A new theoretical methodology, based on these alternative premises, is described. It is suggested that the study of ATI's may be unnecessary for the optimal adaptation of instruction to individual differences. (Author)

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Learner Control: Beyond Aptitude Treatment Interactions (Draft Copy)

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ATI Synopsis via Cronbach and Snow

Cronbach and Snow (1973) have prepared an extensive book length review of the theoretical orientation, the methodology and a summary of research related to an aptitude treatment interaction approach to revision in curriculum and instructional methods. In this paper an attempt has been made to summarize their theoretical position and to examine some of the premises which seem to provide the basis for their argument. Following a synopsis of their argument alternative premises have been proposed which seem to be less limiting than those of Cronbach and Snow. An alternative theoretical methodology is proposed which suggests that the study of aptitude treatment interactions while of interest to a descriptive science may be unnecessary for the optimal adaptation of instruction to individual differences.

The following quotations from Cronbach and Snow present a very brief synopsis of their theoretical position. No short summary can possibly do justice to a complex argument. One always runs the danger of misrepresenting another's

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position by selective ommission of crucial premises or qualifications. The author is desirous of representing the argument as carefully as possible. The serious reader is therefore admonished to carefully study Cronbach and Snow's original work before passing judgment on the alternatives proposed.

Cronbach and Snow suggest that for the most part the accepted theory of curriculum and instructional method in practice today is to provide an equal opportunity for all students. With this equal opportunity students will be able to gain as much as their abilities will allow. They suggest that the flaw in this argument is the assumption of one best method. The ATI argument proposed is opposed to an unidimensional conceptualization of education. An ATI approach is counter to the search for one best treatment.

> "The old mandate was, 'the institution is given, try to pick persons who fit it! The needed mandate is, 'try to design enough treatments so that everyone will be able to succeed in one of them, and route the person into a treatment he fits.'" (Cronbach and Snow, 1973, p. I-18)

> "We urge the social planner to concern himself <u>not</u> with running a fair competition [one where everyone has an equal opportunity in the same race] but with running a talent development operation that will bring everyone somewhere near his highest level of

contribution." (Cronbach and Snow, 1973, p. I-17)

> "If one wants to foster development of a wide range of persons, one must offer a wide range of environments, suited to the optimum development of each person." (Cronbach and Snow, 1969, p. 12)

Cronbach and Snow then argue that the two disciplines of psychology--differential psychology and learning psychology --should come together in an attempt to study aptitude treatment interactions. The result of this study would be a set of principles which would allow one to differentially assign students to treatments in a way that would best facilitate groups of students sharing similar aptitudes.

> "Adaptation to the individual has been a slogan widely held among educators. But such adaptation has never been systematic because no one has known the principles that govern the matching of learner and instructional environment." (Cronbach and Snow, 1973, p. I-23)

> "The ATI approach envisions modifying instruction by periodic decisions...ordinarily at least a few months apart...that assign the person to one or another style of instruction." (Cronbach and Snow, 1973, p. V-7)

Cronbach and Snow advocate a careful research methodology for discovering those "principles" which relate aptitude and treatment variables. Once these principles have been

discovered then the ATI approach to adapting the environment to the individual can be implemented.

ATI Premises and Some Alternatives

The position of this paper toward the ATI approach can be summarized as follows:

It is agreed that the search for a single best treatment is inadequate. It is agreed that instruction should be adapted to the individual. We do not, however, feel that an ATI approach will accomplish this goal. While it is agreed that ATI is a step in the right direction, it stops far short of desirable and possible procedures for adapting instruction to individual differences.

Let's examine Cronbach and Snow's implicit but not always explicitly stated assumptions. For each we would propose some alternatives.

> "'Aptitude' is here defined as any characteristic of the person that forecasts his probability of success under a given treatment. We emphatically do not confirm our interest in 'aptitude tests'...etc., etc.,...new kinds of aptitudes probably need to be detected and measured." (Cronbach and Snow, 1973, p. I-12) We agree! However, other statements of these authors would lead one to believe that they subscribe to the following assumption:

Cronbach and Snow Assumption No. 1: The aptitudes thought to be of value in the study of ATI are those pervasive

characteristics of the individual which are relatively stable over relatively long periods of time. This assumption is reflected by the phrase, "...periodic decisions...ordinarily at least a few months apart..." (Cronbach and Snow, 1973, p. V-7)

Alternative Assumption No. 1: While pervasive trait aptitudes no doubt provide a limiting set of conditions which restrict an individual's range of variance it is, in our opinion, the multidimensional dynamic state aptitudes which change from moment to moment that are more likely to determine the treatment which is most appropriate for a given individual at a given moment in time.

Cronbach and Snow Assumption No. 2: The treatments thought to be of value in the study of ATI are those relatively fixed procedures which are repeated for a group of students and which retain a similar pattern from one occurrence to the next.

Before suggesting an alternative it is necessary to take one aside to define two terms which will enable us to be more precise in stating an alternative assumption. The word treatment is too vague for our purposes. The following are suggested as substitutes.

A tactic is a given display or presentation to the student of rather short duration. One can speak of different kinds of tactics. A tactic is that which happens next in a given instructional treatment. A given treatment

therefore consists of a sequence of tactics.

The word strategy is preferred to treatment. A specific strategy consists of a sequence of specific tactics. There are an infinite number of specific strategies since there are a large number of different tactics which can be combined in innumerable ways. A general strategy consists of a sequence of similar tactics. Each instance of a particular kind of general strategy would resemble other instances of this general strategy but would retain individuality and be distinguishable from other instances of the same general strategy.

Back to the argument.

Alternative Assumption No. 2: That tactic which may be of maximum value to a specific learner at one moment in time is likely not to be appropriate a moment later. That specific strategy which is optimal for a specific learner today is likely not to be the optimal specific strategy tomorrow or next week.

The experience of a human being is dynamic (continually changing). As a result the multidimensional dynamic state aptitudes which we feel most probably predict optimal learning with a given tactic are changing with every momentary experience of a given individual. The optimal next tactic for a given student at a given moment in time is determined by his position at that moment in this multidimensional dynamic state aptitude space. A given person

never has exactly the same configuration of these momentary aptitudes twice in his life. Consequently the search for the interaction of stable trait aptitudes and fixed treatments is never likely to be of instructional value. At the very moment one has identified such a relationship the aptitude configuration of the student has changed, never to be repeated. Hence the finding is descriptively interesting but prescriptively of little or no value.[2]

Cronbach and Snow Assumption No. 3: Throughout their paper Cronbach and Snow speak of adapting the environment or treatment to the individual. An implicit assumption which pervades their argument (and, by the way, the arguments of most persons who argue for individualization) is that the instructor or system will decide what treatment is best for the student--the environment should be adapted to the individual.

Alternative Assumption No. 3: The individual should be given some procedure which enables him to adapt the environment to himself. We feel that the individual should make decisions about what tactic he wants next rather than having this decision made for him.

Assume we could really know, based on generations of ATI research, exactly what should be presented to the student. We put him on our 1984 CAI system and every display is exactly what he needs for optimal learning. What would be the result? We are afraid that like a

spoiled child who is always given anything he wants, the student who always has the optimal tactic provided for him will be unable to cope with the real world which, in our experience, is not so accomodating. Such an adapting-to-the-student procedure will make the student system-dependent. Our goal ought rather to be to make the student system-independent. He ought to be able to learn better after experience on the system than he was before.

How can a student be taught system independence? First, he must be taught to manipulate the system to meet his needs. He must learn to make decisions which adapts the system or environment to himself. He must be given dominion over the system rather than to be placed in a situation where the system has dominion over him.

Learner Control Conclusions

So what? What is the conclusion from these alternative premises?

In our opinion, what is needed is a dynamic general strategy which enables the learner to select at any moment in time that particular tactic which is optimal for his unique configuration of aptitudes at that moment in time. Furthermore, he must be able to select a new tactic on a moment's notice. He must not be required to anticipate his aptitude configuration or the tactic needed more than one step ahead. He must be able to make the change with a minimum of effort. (If all his time or even a significant

part is used up in the mechanics of tactic selection, his learning continuity will be grossly impaired.) He must know how to select a variety of tactics. He must have a wide variety of tactics available to him but not so many that he is overwhelmed by the number of choices. He must be provided a procedure for adapting slowly to this dynamic instructional environment since his previous experience has all been with fixed treatments which have been administered to him and over which he has little or no control.

Cronbach and Snow say: "The needed mandate is 'try to design enough treatments so that everyone will be able to succeed in one of them, and route the person into a treatment he fits.'" (Cronbach and Snow, 1973, p. I-18)

A less limiting mandate is: Let each student select that tactic which is most appropriate for his unique state aptitude configurations during a given interval of time.

Cronbach and Snow say: "If one wants to foster development of a wide range of persons, one must offer a wide range of environments, suited to the optimum development of each person." (Cronbach and Snow, 1969, p. 12).

A less limiting position says: If one wants to foster development of an infinite range of persons, one must offer an infinite range of environments, each uniquely suited to the development of a specific person. This unique environment should not be selected for and administered

to a given learner but should be consciously selected by and modified by that individual.

Requirements for Learner Control

Question? How? What are the necessary steps required to provide a dynamic learner control general strategy.

Answer! Two steps seem necessary. 1. The identification of an integrated set of tactical variables and associated parameters which when combined constitute the variety of strategies possible. 2. The development of delivery systems which enables the easy, deliberate and differential manipulation of each of these tactics and/or the associated parameters by the student.

This paper is not an appropriate vehicle for describing in detail a taxonomic system of tactical variables. Merrill and Boutwell (1973) provided the first attempt at such a taxonomy for cognitive variables thought to affect cognitive learning outcomes. Merrill and Wood (1974) suggested refinements for the previous system and described flow chart conventions for unambiguously describing existing specific strategies in terms of these variables. While neither of these attempts are as comprehensive as might be desirable they do enable the identification of a limited set of learner tactics which can be placed under learner control.

Under funding from NSF and in cooperation with MITRE Corporation, investigators at Brigham Young University

have designed a learner controlled Computer Assisted Instruction system (TICCIT--Two-way Interactive Computer Controlled Information Television). This system was an attempt to implement some of the tactical variables identified by Merrill and Boutwell (1973) by means of a learner control language. This language enables the student to select the next tactic he desires by merely touching a button on a specially designed keyboard. The premises and assumptions underlying the design of this system are described by Merrill (1973). Further description of this system can be found in MITRE Corp. (1974), Bunderson (1973a, 1973b), and O'Neal (1973).

Learner control delivery systems are not limited merely to CAI systems. Gibbons (1974) has described an attempt to provide "unprogrammed" learner control in a self-study workbook-based statistic course. Field testing of this course indicates that students are able to break out of a linear mode and to select that strategy which they feel will best satisfy their momentary aptitude state.

Another major attempt to provide learner control is the work of Gordon Pask (1971) in England. Pask has determined through this work that students tend to have preferences for general strategies that are quite different. Two major classes of such strategies have been identified as wholist and serialist. To a large extent this categorization of learners is determined by a student's self selected

progress through a knowledge network rather than a student's selection of particular tactics for learning a given concept or rule within the net. Within this system Pask has also provided the student considerable flexibility in selecting his own tactics. For the most part, however, the tactics made available to the student within Pask's system are somewhat uniquely tied to the subject matter being presented rather than being general tactics which can be applied to a wide variety of subject matters.

Learner Control Research Questions

A learner control approach to individualization of instruction suggests considerable variation from the research methodology suggested by Cronbach and Snow. It is suggested that the determination of aptitudes may not be necessary to this work. Rather the following types of engineering research questions are of interest.

1. Learner control language. Can a learner control language be devised and delivered to a student in such a way that students who are allowed to control their own strategies by selecting moment to moment tactics will perform better on appropriate criterion measures (including efficiency and effectiveness) than students who are given any type of fixed strategy?

2. Transfer of learner control. Can a learner control language be devised that has sufficient generality that the student's use of this language will transfer to other

learning situations besides the delivery system on which the language was orginally taught? In other words can a universal, delivery system-independent, tactical language be devised?

3. Acquisition of learner control. It is a fact that in most current learning systems the student does not have tactical control or, in most cases, any form of content control. Can a training system be devised that will allow a student to gradually acquire more and more tactical control? Correlative questions are as follows: Given control of a single tactic, what tactic has the greatest payoff in terms of learning gains? What tactic added to the first provides control of the greatest portion of the remaining variance, and so forth for additional tactics? How many tactics can a learner control within a given learning situation before the number of controls available has a disruptive effect on his learning? Does this number vary with children of different ages? Can a student be taught to use a variety of strategies as may be appropriate to various kinds of learning situations? Is the use of such a variety of strategies correlated with more efficient learning in these situations?

4. Learner control and ATI. In conclusion, we come full cycle and pose questions which we initially rejected. Is it possible that there are trait aptitudes which enable one student to benefit from one type of learner control

while another student might benefit from a different type of learner control. Pask (1971) seems to have already demonstrated (within the domain of content control) that some students do better with a wholest approach while others perform more adequately when using a serialist approach. Under his system a single learner control language allows both approaches thereby making the assignment of students to treatments on the basis of this wholist-serialist trait unnecessary. Is it conceivable that such universally applied learner control is not equally beneficial to all students?

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FOOTNOTES

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The ideas represented are the result of lengthy interactions with the author's colleagues during the past two years and special acknowledgement must go to them. C. Victor Bunderson's work on learner control and aptitude treatment interaction at the University of Texas CAI laboratory first oriented our thinking in this direction. The leap beyond fixed treatments must be credited to Harvey Black who insisted on the concept of "local control." Gerald W. Faust was a major contributor in all of the design meetings where the details of the TICCIT CAI system were hammered out. All of our associates on the project have greatly contributed to the ideas presented. This paper, however, represents the author's synthesis of these discussions and the reader should not hold my colleagues responsible for faulty premises or logic which may be discovered in the arguments presented.

[2]H. A. Simon (1969) has made an extremely useful distinction between artificial and natural science. Natural science

is descriptive while artificial science is often prescriptive. Natural science deals with events occurring in the real world while artificial science deals with man-made artifacts. Instructional science is in our opinion an artificial science rather than a natural science. Based on the arguments presented the study of ATI's are of value and are in the domain of the natural science of psychology but are unlikely to be of primary value in the artificial science of instruction.